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CIVIL AIR PATROL
AUXILIARY UNITED STATES AIR FORCE

THE PROBLEMS OF AIR POWER

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THE PROBLEMS OF AIR POWER

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Foreword

Outside of comprehending Air Power's role as a weapon of war and a means of transportation, few of us wholly understand its social implications and its problems. We take for granted the nation's flow of economic, political and industrial progress. But do we realize to what extent this flow of progress is fed by American Air Power? And to what extent Air Power itself has within it the potential to solve the problems its progress generates? We, the people, must learn about these things for only we can direct Air Power into the fruitful channels for which it is destined.

Air Power's story is unfinished. Yet its achievements, as courageous and thrilling as any we will find in our nation's history, have already re-shaped the face of the world. It is now on the threshold of uncovering tomorrow's new vistas. Its new inventions will alter the course of human destiny, for better or worse. To the youth of America, aviation offers a richness of opportunity offered to no other generation. On no other generation has society depended so much to help solve world problems intensified by aviation. But first there must be understanding of these problems. And through understanding, Air Power will fulfill its destiny of serving mankind's ultimate betterment.

WALTER R. AGEE
Major General, USAF
National Commander
Civil Air Patrol

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Preface

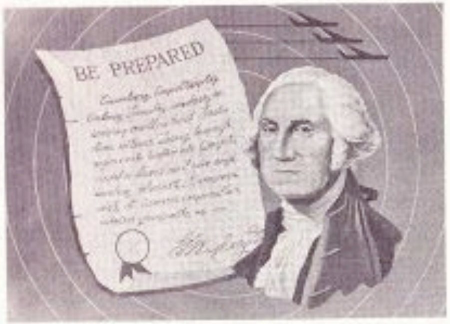
Air Power and its Problems is the sixth and last of a series of pocket-sized books prepared for use in the aviation education program of the Civil Air Patrol. It is supplemented by a 35 mm. instructional filmstrip, in sound and color, that highlights its major points.

This book discusses the major problems of Air Power, civil as well as military. Because the total civil-military picture of Air Power is so vast, a comprehensive treatment of its problems was impossible under the limitations of space and time. The scope of the subject material, however, is broad enough to provide Civil Air Patrol cadets and others some basic understandings of Air Power problems. Some of these problems will be familiar. Others will be new. Together they are important enough to constitute a national crisis in the world today.

It is essential that our youth and adult citizens grasp the concept of Air Power as not belonging solely to an arsenal of military weapons. On the contrary, there can be no Air Power without the civil element—the aircraft manufacturing, the air transportation, the airports, the industrial and scientific research. And yet, paradoxically, the strength of the civil element of Air Power is to a large extent nourished today by the needs of military aviation. The conclusion to be drawn is that they are inseparable. Both make the entity of American Air Power. And this is the way it should be. They both have common objectives—the well-being of all the people.

This is the central theme of the book. Understanding it is necessary if the goals of aviation education are to be attained. This book will help students and teachers attain those goals.

MERVIN K. STRICKLER, JR.
Director of Aviation Education



CHAPTER ONE

I. INTRODUCTION

George Washington once said, "To be prepared for war is one of the most effectual means of preserving the peace." These words are as alive today as they were 180 years ago. The concept they illustrate lies at the core of our national defense program. The principle the words express is old; the means we have adopted to preserve the peace is new. Air power is our modern method. "Air Power is Peace Power." Until a better way for achieving a lasting peace is discovered, the American people must use, as its principal instrument of defense, air power, the most powerful instrument of peace known today.

The Nature of Air Power

When some people think of air power, they think only in terms of military aviation. However, among the problems of national and international aviation some are civil, some are military; others are both civil and military. The strength of our nation's air power depends upon the continued development and stabilization of a great aircraft manufacturing industry, upon the continued growth of the air transport industry, upon civilian research and development, and upon the creation of an air-minded public. The problems in these areas are numerous. Many of them have international implications.

Military aviation in the United States includes not only the United States Air Force, but also Naval and Marine aviation and the aviation operations of the Army. Aviation is so important to national defense that every branch of the military services makes use of it.

The Elements of Air Strength

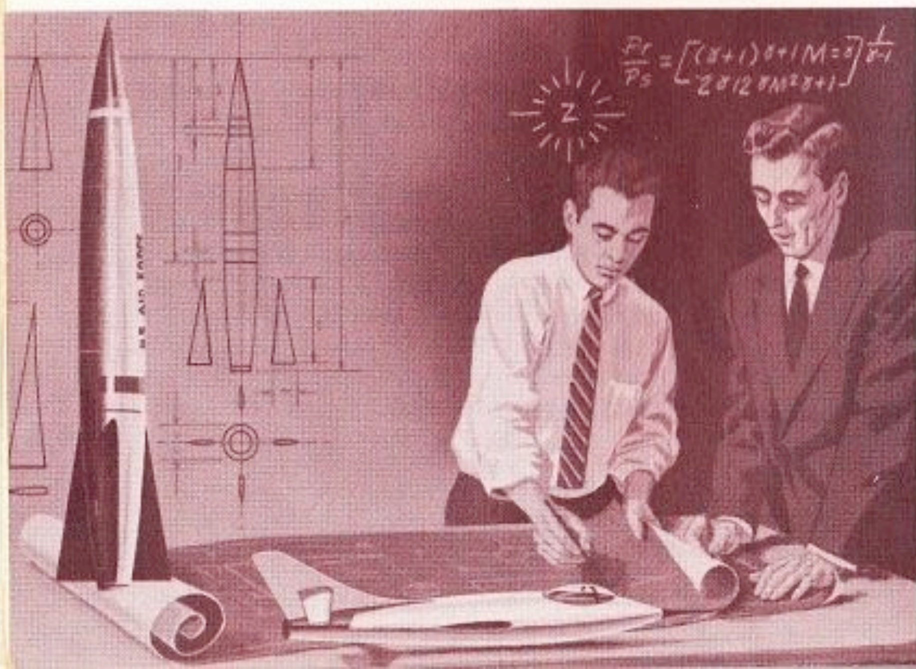
We can convert the military force of our air power to constructive civil use, but first this same force must be strengthened to give us the conditions for such a conversion. It must be made to attain such magnitude as to accomplish two things: (1) it must make a potential aggressor stop and think before attacking us and, unless he is bent on suicide, to lay his arms aside and agree to seek peaceful ways of settling differences; (2) in case of attack, to launch an immediate counterblow against the aggressor, retaliating with such violence as to remove the possibility of any further attack.

To achieve either of these objectives presents problems that almost defy solution. It is not easy for a democracy to go all-out in preparing for a war during peacetime. Such preparations demand continued high taxes and impose other severe restrictions on the people. These preparations could become reminiscent of the all-out effort of World War II. Whether such an effort becomes necessary only time will reveal. If it becomes necessary it must be made regardless of cost. For whatever the cost, it would be dwarfed by the expense of another war.

Indications are that this nation will not commit itself to an arms production race. While the importance of quantity of air power is recognized, our main efforts will be devoted to achieving superiority of weapons, the finest that science can discover and money can buy. The rapid technological changes taking place in aviation seem to support the view that a concentrated production of a particular model or models of aircraft is not only unwise but also wasteful. It can well be that a particular aircraft in production will become obsolete in the time it takes to fulfill the production orders.

In order to maintain a strong modern Air Force in-being, one capable of launching a crushing counterblow, the factors described following are essential:

1. *A strong aircraft industry.* It must be a going and ready industry, capable of immediate expansion when necessary, and capable of producing the aircraft and weapons needed to guarantee air superiority. Such an industry is not only the backbone of our security but it is a dominant force in shaping a strong national economy.
2. *A strong civil air transport system including utility aviation.* As with the aircraft industry, these, too, have a dual function. In time of emergency they offer a reserve of airplanes, experienced personnel, and a communications and navigation system. In peacetime they are a vital force in our national economy.
3. *Airports and air bases.* We need military air bases from which we can intercept the enemy before he reaches his target. And our civil airports must be modern and plentiful to accommodate both military and civil aircraft when the time comes.
4. *Continuing research and development program.* Research is the key to superior quality. There must be sufficient funds available to government, industry, and the military services to carry out the three essential steps in achieving superior air weapons: (a) pure research (by the government), (b) development (by industry) and, (c) evaluation of products (by the military services).



Factors Influencing the Elements of Air Power

The four factors set forth above, in turn, depend on various others. Skilled personnel, for example, are an essential ingredient of both civil and military aviation. It takes years of training to get maximum efficiency out of the pilots, mechanics, electronics specialists and the many other technicians that are vital to both a stable aviation industry and a modern efficient Air Force. These specialists must be retained as teams to prevent disruption of operations as well as costly re-training of new personnel.

The federal government's role is significant, particularly in civil aviation. Legislation and policies must be strong but flexible enough to create the conditions that encourage healthy competition and growth in civil aviation. These conditions, which are essential to a strong national economy, result from domestic and international trade and commerce, travel, and transportation. The federal government also plays a leading part in safety regulations and in the support given to all aviation interests through research services, air traffic control, airport construction, mail pay, weather information, and many other services.

Air power begins and ends with a strong national economy. A strong national economy makes it possible to pay the bills security demands. A strong economy means a thriving domestic and international exchange of commerce, expanding trade and manufacture, discovery of new materials and discovery of new uses for old materials, new markets, and a stable, well-paid expanding labor force. These are the things that nourish our national economy, and civil aviation provides a sizeable share of the vitamins, billions of dollars worth.

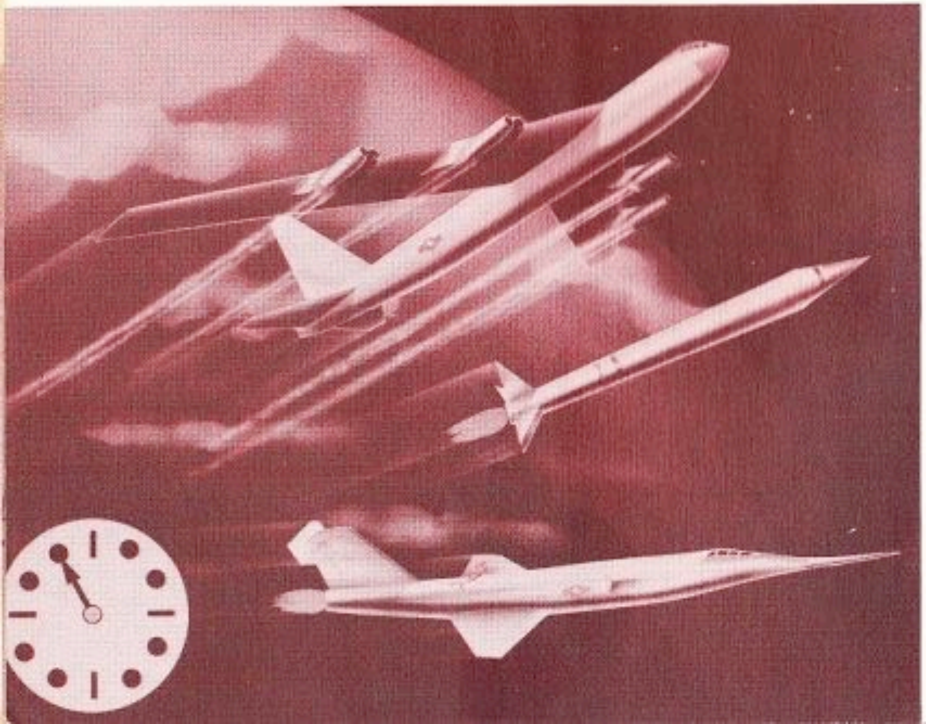
Civil aviation, itself—the vast systems of air transportation, the aircraft industries, and utility aviation—contributes significantly to the nation's economy. It employs a labor force of about one million people. It has an industrial payroll of over four billion dollars, the nation's largest for a single industry. Its export of aeronautical products is greater than that of any nation in the world. Its tremendous coverage of domestic and foreign air routes makes Americans the most air-travelled people in the world.

The aircraft manufacturing and air transport services are important equally to our air power. If these services are kept adequate, we can achieve our goal of air power superiority.

The elements essential to achieving air power superiority have just been listed. They now give rise to some burning questions. Just how powerful is our air power right now? Is it ready? If not, what needs to be done to get it ready?

Today, the Congress, the military services, the industrial world, and the people are attempting to puzzle out the answers to these questions of our security. While they are doing it, a disturbing question looms ever larger on the horizon: Do we have enough time?

Time is the prime essential of our defense preparations. But time is consumed by the complex problems that accompany each technical and social advance of air power. Many of these problems have already been solved. We expect that the others will also be solved. But time is of the essence and the problems remaining are very real, very urgent, and unless they are solved very soon, a situation may develop which will become extremely dangerous to the survival of our nation and, conceivably, of civilization.

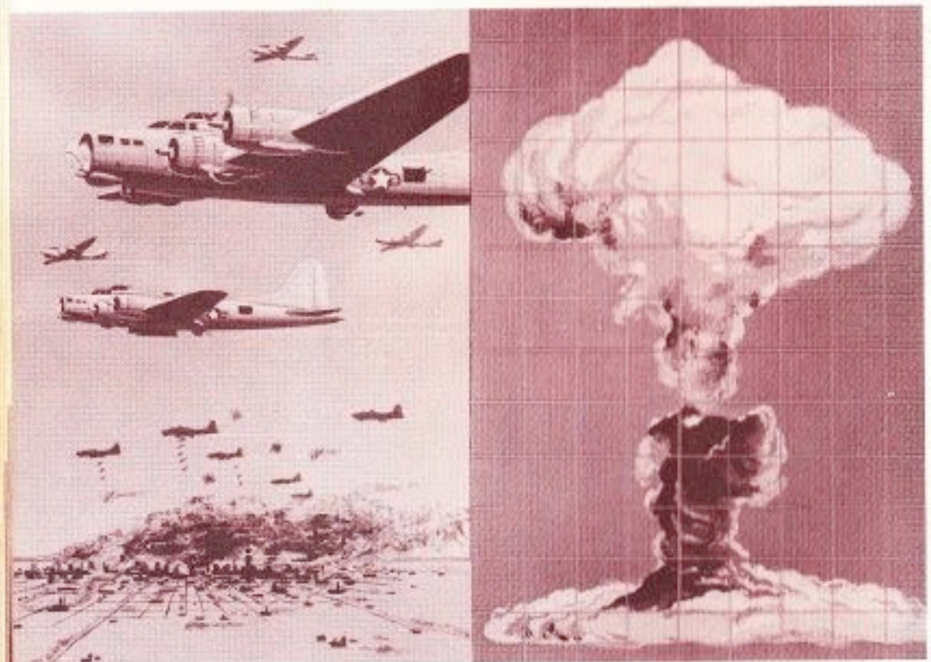


CHAPTER TWO

II. MILITARY AVIATION

The Destructive Capabilities of Military Air Power

The destructive qualities of military air power make it a formidable war weapon. The combined Allied bomb tonnage dropped on all types of German targets during World War II was 2,638,000 tons. However, all of the bomb tonnage dropped on German targets during World War II contained only one-fifth of the destructive power of just one in today's family of "average" nuclear bombs.



Two aerial atomic bombs proved to be the decisive factor in ending World War II. A single, experimental hydrogen bomb set off in the Pacific several years ago blasted a hole in the earth's surface 175 feet deep and a mile wide. The crater was big enough to accommodate the business section of an American metropolis. That single bomb had the force of a million tons of TNT. Today's H-bombs make that one obsolete.

Multiply the effects of a modern H-bomb by the combined force of all the nuclear bombs now available, add the total force of the transonic and supersonic fighters, the intercontinental jet bombers, and the guided missiles. It would be possible for the nation possessing such power to control the air space over any other nation, to impose its will on that nation, and to strangle it by shutting off its source of food supply and manufacture. The nation controlling such force could control the destiny of the world.

The Threat of Military Air Power

Our nation is neither invincible nor is it immune to attack. High-altitude, intercontinental bombers can fly direct air routes between any two points. The distance from Moscow to either New York, Philadelphia, Baltimore, Washington, or Chicago, by the polar route is between seven and eight hours flying time for the Bison, the Soviet version of our B-52. A fleet of such bombers releasing its devastating bomb load upon us could destroy within an hour much of our military, economic, and industrial strength and maim or kill thousands of our people.

By 1956 the Soviet Union had successfully conducted about 25 atomic and hydrogen bomb tests. She is also known to possess the *means* to deliver nuclear and thermo-nuclear destruction. She operates from 18,000 to 22,000 first line combat planes with about the same number in reserve. An estimate of her current plane production is from 12,000 to 17,000 aircraft annually. She has in operation the long range jet atomic bomber. She also has jet medium bombers and modern fighter-interceptors to employ for attack and defense. The Soviet Union is also known to have over 20 bases for launching guided missiles. Some authorities believe that she already possesses a 1500-mile missile and that she is making rapid progress toward developing a 5000-mile ballistic missile. On top of these uneasy facts, let us take note of another: namely, her scientific and technical engineers are as capable of solving the complicated problems of Air Power as ours are, and thousands of Soviet youth are undergoing engineering training.

The Air Power strength of the Soviet Union did not develop overnight. She has been long aware of the importance of a strong air force. Her air power has advanced rapidly for thirty years. Its rise during the past ten years has been phenomenal. In 1956, the Soviet Union

announced plans to reduce her military forces in order to expand her agricultural and industrial capacity. This step will enable her to produce even more air-war material, and it also will strengthen her position as an economic competitor of the Free World.

The loss of global prestige that the United States could suffer on the economic front as a result of widening Soviet influence could mean the loss of allies. This loss could be equally or more damaging to our national security and economic welfare than a military defeat. Moreover, all attempts to reach a full disarmament agreement with the Soviets have been ending in deadlock.

The gravity of the situation cannot be underestimated. Events could suddenly get out of hand and war could break out. This possibility was emphasized by a number of events of the last 10 years. Potential trouble spots exist throughout the world today—in the Middle East, the Near East, Africa, and Asia. A seemingly trifling local "incident" could set the world on fire.

The Problem of Peace

The United States has dedicated itself to finding a mutually satisfactory and peaceful solution for the problem presented by the East-West "cold war." The American people, however, are in agreement that, under present world conditions, it would be unwise to effect any sizeable reduction in the nation's military strength. They have chosen, on the contrary, to increase their investment in Air Power, the instrument of national defense.

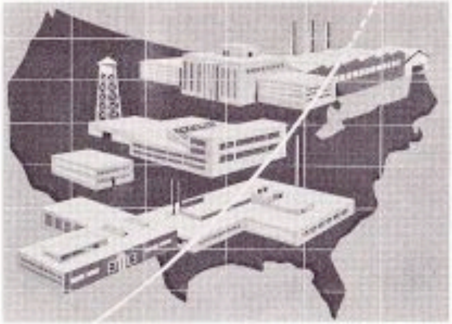
Air Power is Peace Power

This slogan is the keystone of our military policy. It has dominated our national security and economy since World War II ended. Some say it has prevented World War III.

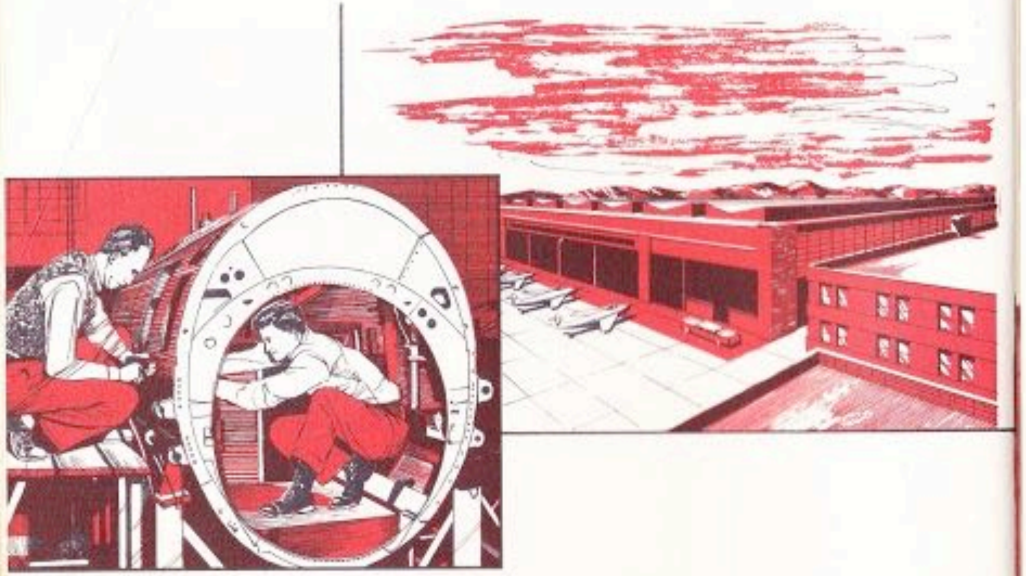
From one point of view, it is an expensive slogan. In 1941 the nation bought $587,000,000 worth of military planes. Today we spend almost 15 times as much for military aircraft as we did in 1942 when the country was at war. Today one dollar out of eight of the federal budget goes for the purchase of aircraft. Fifteen billion dollars, 43 percent of the total Department of Defense budget for 1956, went for U. S. Air Force operations. More billions have been appropriated for naval aviation.

Today from 85 to 90 percent of the aeronautical products manufactured by industry fill military orders. (Air Power, incidentally, is not unique as a high cost defense item in the federal budget. Statisticians have estimated that since 1915 about 85 percent of federal funds has been spent either for war, preparing for war, or paying for a war after it was over.)

Air Power is the most voracious consumer of money, natural resources, electronics, metals, and human talent yet created by man. In its search for faster, higher, heavier, and more far-ranging planes; for long range missiles; and for the ultimate aerial weapon of destruction—and defense—whatever it may be, it has imposed tremendous cost and has taxed the very limits of human endurance. Yet the objective of American Air Power is paradoxical. It seeks peace, not war. Its great hope is never to see combat. Its great hope is to speed up the day when the world will know real peace, when a large part of a nation's military resources can be converted for constructive uses and make friendly neighbors of the two and a half billion people that live on the face of this earth. Air Power has this force within its grasp. A real peace would release it. A real peace can open up world-wide channels for educational, economic, social and cultural improvement through Air Power, so that all men may have a chance to live a free and better life, and men of different faiths and customs can come together to discover that they do have many interests in common. A real peace will be worth all that it costs.



CHAPTER THREE



III. AIRCRAFT MANUFACTURING

From the day it was born the aircraft manufacturing industry has suffered from instability. It rides with the times. In normal periods its existence depends on public whimsy; international crises wrench it into a prodigious round-the-clock production effort. Thus far, it has never failed to meet the demands made upon it. Today its problem is how to keep itself strong and ready to cope with an emergency.

One might say that World War II put the aircraft industry on its feet, the postwar period knocked it down; Korea picked it up again, and the present East-West race for air supremacy is the main reason why it keeps standing. In peacetime it has been the most neglected of our major industries; in wartime it has been asked to do the impossible. Under such circumstances, it is hard for a young industry to develop.

Historical Background

The names that are making aviation history today—like Boeing, Douglas, North American, Martin, Ryan, Curtiss, Lockheed, Northrop, Consolidated Vultee, Fairchild, and Republic—were hardly known before the mid-thirties. During their early years most of these firms barely

managed to stay alive. The American public was slow to accept the airplane as useful beyond what it then represented: sport, airmail, and a new war weapon. Air transportation was flourishing but not in America. While American manufacturers possessed the know-how for building excellent aircraft, funds for their production were not available. France, Great Britain, Italy, Germany were blazing the commercial air trails.

But by 1935, the climate began changing. Trouble spots broke out in Europe. Orders for military aircraft began coming in, slowly, mainly from foreign nations. American plane-making gathered momentum and by 1939 when war had come to Europe, U. S. production lines were assuming respectable proportions. That year the industry turned out 2,195 military aircraft. With a mounting backlog of orders demanding attention the industry cast around for more working space. By January 1940, it was spread out over 13 million square feet of space, about 4 million more over the year before.* In exactly one year, its work space was doubled, and its production tripled. After Pearl Harbor there began the most fantastic climb in the mass production of aircraft that the world had ever seen.

During the years 1941-45, American aircraft manufacturers turned out almost 300,000 military planes of every type—bombers, fighters, transports, and trainers. Peak production was reached in 1944; over 96,000 planes were delivered that year. The American aircraft industry had achieved what our enemies and our European allies had believed impossible.

Postwar Setback

Wartime industrial aviation represented 35% of the country's total defense effort. Over a million and a half people worked in airplane factories. Airplanes filled the skies. The air-age appeared to have engulfed us. Everyone believed that the crest of the rising aviation tide would provide endless job opportunities for returning veterans.

They were quite wrong. After the close of World War II, cutbacks and cancellations in the plane-making business were as swift as had

*The floor space of aircraft industry plants is a rough index of the industry's readiness for emergency production. World War II peak, in December 1943, was 175 million square feet.

been the wartime expansion. Commercial demands would not carry the industry through the hard years of postwar readjustment. The demand for light planes died quickly; the brief postwar boom in private flying became a bust.

Caught between the loss of contracts and inflationary costs, airplane makers turned to manufacturing other products, such as bicycles, refrigerators, and stoves. But they continued to suffer losses because they could not compete economically with the established manufacturers of these goods.

A steady decline took place in plane-making between the years 1947 and 1949. The industry was practically demobilized; research and development came virtually to a halt.

The feast-or-famine nature of the aircraft business can be illustrated by the experience of North American Aviation, one of the major companies. That firm went from a profit of $14 million in 1945 to an operating loss of $12 million in 1947.

Effects of Korea

When the Korean war broke out in June 1950, our entire military aircraft production rate was only about 2,500 planes a year, *almost 17,000 less than the year's production preceding Pearl Harbor!* Fortunately, we had a jet fighter, the F-86 Sabre, to put up against the Communist MIG-15. United Nation pilots claimed that above 30,000 feet the MIG, a lighter plane, could outclimb, outspeed, and outmaneuver the Sabre. After three years of combat, however, the "kill" record stood at 801 MIGs destroyed to 58 Sabres. Some Air Force officials attributed the F-86 record to the comparative superiority of the training received by our pilots, and not necessarily to the technical superiority of the plane.

The day we went to war in Korea, the federal government asked the aircraft industry to perform a production miracle. And, by 1952, the industry had once more achieved the impossible. It had tripled the aircraft production rate, hired over 350,000 additional workers, and established research and development programs. By the end of 1954 the industry was building 9,600 military planes a year—jet fighters, bombers, and cargo planes—as well as guided missiles and civilian aircraft of all types. It was now using 127,500,000 square feet of floor

space—about twice what it had in 1950. This was as much as 75% of the maximum work area of World War II. To give you an idea of the tremendous amount of space needed today to build modern aircraft, consider these figures: in 1942 we were producing almost 48,000 military aircraft a year and using 117 million square feet of factory floor space; in 1954 we were producing only 9,600 planes a year—one-fifth the number built in 1942—but using 127.5 million square feet of space! The cost of new machines and buildings needed in the Korean expansion almost equalled that of World War II—approximately $3,530,000,000. The aircraft industry provided one-third of the funds; the rest came from the government and private investors.

The reconstruction of the aircraft industry, begun June 1950, has been largely completed, except for some specialized new construction needed for guided missiles. The job asked of industry was difficult and expensive, although it was made easier by the industry's World War II experience. Part of the expense was no doubt caused by the high cost of today's complex aircraft. But the most of it was caused by the need to set in motion and then to expand an industry that had been allowed to come to a standstill.

Need for Steady Production

Did you know that during World War II all planes (including the B-29) used by the United States had been designed before December 7, 1941? This fact leads one to conclude that the U.S. Air Force, in the event of another war, will use the general types of aircraft which it has on hand when the war breaks out. Once a war is underway there will be little time to develop new weapons, and production facilities will be shifted almost entirely to a quantity turn-out of the best existing models.

The aircraft industry must be geared to a long range plan that will assure it stability and freedom to develop superior weapons, to retain its teams of experienced engineers and scientists, and to maintain a state of readiness to produce the aircraft needed to guarantee air superiority. Only a long range plan will prevent the wasteful practices of past years. It has been estimated that the nation can buy its air power 25 percent cheaper through such a long range aircraft procurement program.

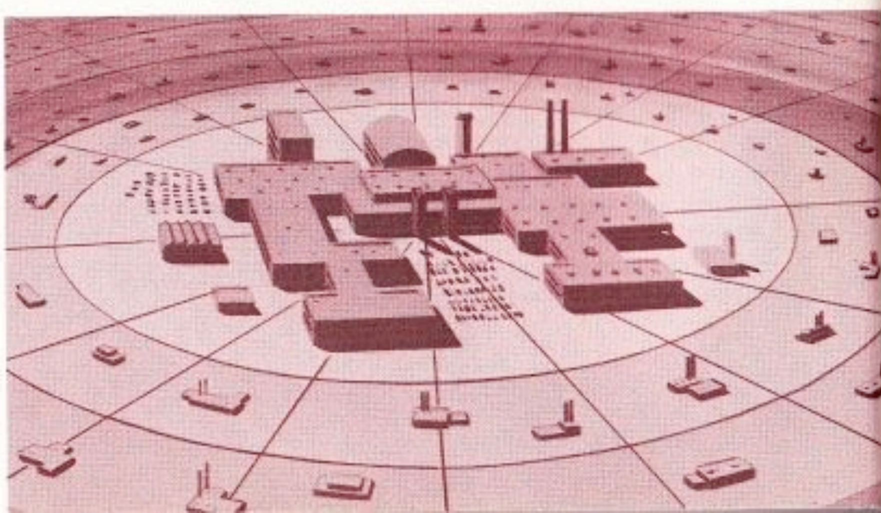
"Lead Time"

The Air Force we need today will not grow overnight. Today it takes from 7 to 10 years to develop a new combat plane from the engineering board to production. That is how complicated aircraft manufacturing has become. The development of the Convair F-102A is an example. This aircraft is a supersonic, delta-wing jet interceptor. It is equipped with air-to-air guided missiles, 2-inch rockets, and a fully automatic electronic fire control system. The U. S. Air Force has called it the "deadliest weapon of aerial combat man has ever flown." This aircraft was first designed and tested in 1948. Its delivery to the Air Defense Command began in mid-1956.

One of our giant strategic bombers has over 184,000 separate parts. It took nine years of incubation from drawing board to production. Tomorrow's weapons will take even longer to produce. Time is essential—time to establish requirements, time to design, time to award contracts, time to build experimental models, time to test them, time to produce them, and time to improve them. In the aircraft business this time is known as "lead time."

Complexity and Specialization

The complexity of modern aircraft manufacturing is such that no one company can undertake to produce all the parts an aircraft needs. For example, during 1954 almost $5 billion was paid by 35 major aircraft manufacturers for services and products received from subcontractors and suppliers. About 50 percent of this sum was paid to 50,000 small businesses (employing fewer than 500 workers). Among these small industries was represented every state of the union and



18 foreign nations. Aside from the buoyant economic effects such transactions have on the nation, they illustrate the high degree of specialization necessary to produce modern aircraft.

Not all subcontractors can meet the exacting specifications established by the military services and the major contractors for making an aircraft part. Others do not have the experienced personnel needed for assembling a plane or a missile. Many concerns do not have the gauges and other precision-measuring instruments necessary for inspection and testing. Other firms do not have the facilities for heat treatment, magnaflux, anodizing, or plating. Others do not have special-purpose machine tools, such as large stretch-forming machines, large hydraulic presses, and large special-purpose milling machines.

Modern high performance airplanes require new and difficult methods and production techniques. The airframe manufacturers must use thicker metal sheets, harder materials, and closer tolerances than those used in the past. In the past, many parts were bent into shape, now they must be machined into shape. There is a big difference. It means more complicated structures and joints, more difficult riveting methods, and the need for more and better assembly tooling. It means, too, that today's small and large airplane manufacturing companies must meet standards of craftsmanship that surpass all previous quality requirements. Mistakes, lack of skill, and unsuitable machinery can jeopardize vital production schedules; the delay of our production schedule can be a costly liability to the national welfare.

Industry—A Target of War

Experience, skills, technical ingenuity, daring, and fortitude characterize today's aviation manufacturing industry. All of these are assets that cannot be measured in cash. These assets have earned universal respect for the aircraft industrial power of the United States. It was this industrial power that gave the Army Air Force the muscle that destroyed Germany's means of continuing World War II. American air power wrecked German industries. Consequently, Germany could produce neither new type planes nor the types in current use. The end was inevitable. The collapse of the German war industry brought about the collapse of the Germany economy. The collapse of the armies had to follow.

America had two and a half years to amass the concentration of air power that led Germany and Japan to unconditional surrender. Never again can our country delay preparations until hostilities begin. The next war will be fought with the equipment on hand at its outbreak. For this reason, to have only a second best Air Force is to court disaster.

In the event of a third World War, the destruction of the aircraft industry will be a prime target for an aggressor. No matter how widely dispersed its facilities may be, it is conceivable that the entire complex could be demolished within hours. Unless the nation is equipped with a superior air force at the very moment this happens, its ability to wage war will be paralyzed and it will be at the mercy of its enemies.

Plane-Making and the National Economy

To rely upon a hit-or-miss, unstable aircraft industry is damaging not only to the nation's security but also to its economic welfare. An unstable industry would retard the development of our air transportation system. Our commercial airlines, in turn, bear a profound influence on our general economy. During 1956 the combined revenues of the aircraft manufacturers and the airlines will add as much as $10 billion to our national economy. Just 12 of the 35 major airframe manufacturers gross annual sales of over $5 billion. In dollar volume the aircraft manufacturing industry ranks second of all major industries in the nation. In 1954, the Boeing Aircraft Company was one of the 29 U. S. corporations listed in the $1 billion or more annual sales category.

In addition to the aircraft industry's direct effect upon our economic health, it has an indirect effect through other industries. Aluminum makes up about 70 percent of all material used in aircraft construction. Fifteen percent of the aluminum used to build planes is steel alloy, five percent is magnesium. Other materials used are bronze, brass, wood, plastics, copper, rubber and nylon. Titanium, known for many years, is under heavy industrial development because its properties promise to help solve a number of critical engineering problems. The industries that furnish these materials grow as the aircraft manufacturing industry develops.

It would be safe to state that much of the phenomenal progress being made by electronics today is the result of efforts being made

to meet aviation's problems. Take what many say has been the most revolutionary "gadget" to hit U. S. industry in the last ten years: the transistor, a metallic sliver about the height of a carpet tack with a few hair-thin wires attached. The wrist radios you see advertised have them. First used in hearing aids, in a jet fighter it reduces the plane's weight by 1500 pounds. It takes the place of the vacuum tube, but doesn't wait to warm up·like the vacuum tube, saves space, weight, heat and power, and lasts 150 times as long. By cutting the plane's weight and doing away with an extra power plant and housing for the refrigeration system, the transistor will save about $50,000 in manufacturing and operating costs for *one plane*.

Progress and Problems

The future looks bright for the aircraft industry. The 1956 decline in orders for military aircraft was counteracted by an increase in orders for guided missiles.

Since 1950 the nation has spent over $82.25 billion for military aircraft required by the Air Force and the Navy. Billions of dollars more have gone for related procurement. During the fiscal year 1957 the basic requirements of our 137–wing Air Force will be met. Aircraft production will then level off to a point needed to keep the Air Force up-to-date, well-equipped, and capable of meeting any attack whenever and wherever it comes. To sustain such an organization with modern equipment will take an annual investment in *new* aircraft very little less than that expended today. Will the people of the nation approve it? Will the expense of maintaining the military strength needed to fight a cold war be tolerated indefinitely?

Changes in our international relations could dictate a radical revision in the nation's defense structure. The results of such a revision could be for the better, or, for the worse. One thing seems certain. The aviation industry's potential is practically untapped. Eventually its development will depend as much upon civil aviation as it now does upon military aviation. Eventually the current top-heaviness in military production will be counter-balanced by civil aircraft requirements. In 1955 and 1956, $2 billion worth of orders for aircraft were placed with the industry. Of this amount, $1.5 billion were orders for either turbojet or turbo-prop air transports. At present it is estimated that $3 billion will be spent for civil air transports to be delivered by 1965. Large orders for civil aircraft, such as these are, will give continuity to aircraft manufacturing operations and enable the industry to expand speedily when emergency military needs make expansion necessary.

CHAPTER FOUR

IV. AIRLINE TRANSPORTATION

The Beginning of the Airlines

Civil air transportation got its start in this country with the passage of the Kelly Bill, the Airmail Act of 1925. This bill made it possible to award air mail contracts to private airlines.

Much of the flying activity throughout the country at the time was centered around air shows, air races, and barnstorming events. There was little commercial airline traffic, and flying the airmail was a federal government enterprise administered by the Post Office Department. In 1926, the airlines carried only 5800 passengers; today, they carry passengers at the rate of 42 million a year. In 1926, domestic air routes totalled only 3600 miles; today, a network of approximately 80,000 miles of air routes covers the country.

It wasn't until 1930 that airmail contractors became interested in purchasing aircraft large enough to carry passengers profitably. This came about with the enactment of the McNary-Watres Bill, which directed that air mail contractors were to be paid by space available instead of by the pound-per-mile rate. Operators now found it profitable to order aircraft with more cabin space, install seats, and add to their income by promoting passenger traffic. Available space was paid for whether filled by mail or not. Under such circumstances any passenger revenue was clear profit. However, people still showed no great eagerness to travel or ship by air. Civil flying had not yet been brought under formal regulation and flying accidents were frequent.

The Beginning of Federal Supervision

The enactment of the Air Commerce Act of 1926 brought under federal supervision the safety aspects of flying, such as pilot fitness, aircraft air-worthiness, potential fire hazards, and proper airport marking. The Act did little more. Federal control was still only partly effective, because government authority was spread over too many agencies. However, in the years following, the improved safety record of aviation, coupled with some overall technical improvements in airline service, paved the way for an increase in passenger traffic.

By 1932, the airlines were becoming self-sufficient. Mergers had brought into being coast-to-coast trunk lines. Three-mile-a-minute luxury liners had replaced the slower tri-motor transports. In spite of the existing economic depression, passenger traffic was increasing at the rate of one-half million passengers a year. Thirty-four mail routes operated 27,062 miles of air routes. Moreover, the cost of carrying the mail was down from a ton-mile rate of $1.10 in 1929 to $0.54 at the beginning of 1933.

A Difficult Period

Air transportation appeared to be growing into a stable industry when the government on February 9, 1934 suddenly cancelled all air mail contracts, assigning to the Army Air Corps the task of carrying the mail. The first week of this operation proved the action unwise. Five pilots were killed; six critically injured; eight airplanes were destroyed; and property damage of about $300,000 was sustained. On March 10, 1934 air mail service was abandoned. Immediately there was an increase of 110% in the volume of air express. Business men had learned the value of air mail and although done in violation of postal regulations they were shipping bundles of letters by air express. On April 20, 1934 air mail contracts were again let to airline transport companies.

Both the air transport industry and the federal government learned some valuable lessons during the early months of 1934. Among these was the conviction that (1) a healthy air transport service was essential to the nation's economic and political strength and (2) the time was at hand to revise the existing air legislation. However, it took four years of discussion before satisfactory legislation was finally enacted.

A Solution to the Problem of Aviation Regulation

In order to do a good job for both the airlines and the public, the federal government must have regulatory power over the airlines. It must regulate air commerce in the same way that it regulates interstate and foreign commerce. The authority by which it conducts these functions stems, of course, from our Constitution.

The Air Commerce Act of 1926, the first bit of legislation concerning the operation of the airlines, limited itself mainly to the factors of safety. To provide the practical machinery for the development of air transport services was left to its successor, the Civil Aeronautics Act of 1938. This Act not only helped to revive the airlines but it also

stated continuing, public-service objectives and established the means to put these objectives into force. It also marked a new high in Government-Business relations by giving private industry the opportunity to run its own affairs, while remaining accountable to a Board with wide powers acting as a referee. The function of the Act was not only to regulate the airlines but to stimulate their growth and consequently strengthen our commerce and their role in the drama of international air power.

During the period of time between the passage of the Civil Aeronautics Act of 1938 and 1956 the number of scheduled airlines had grown from 22 to 53, domestic and international; the number of cities served from 286 to 695; the number of passengers from 1,536,000 to approximately 42,000,000; and the amount of cargo (mail, express and freight) from 10,381,666 to 484,662,000 ton-miles.

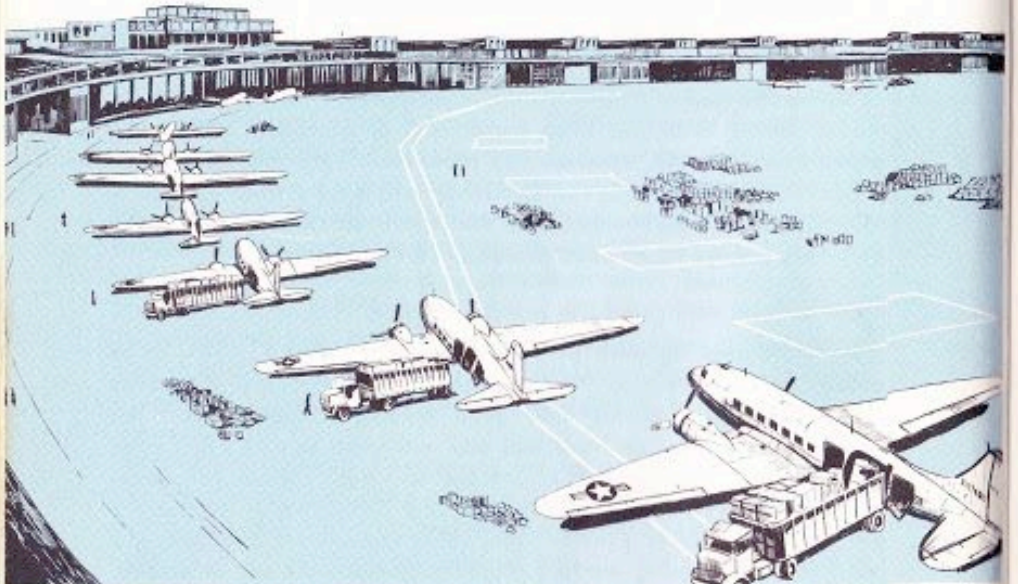
The Beginning of a Military Air Transport Service

In hardly anything were we as weak, on December 7, 1941, as in military air transportation. The problem of placing men and supplies where they would do the most good seemed insurmountable. The military cargo planes on hand that day numbered exactly 27. Eleven were crudely converted B-24's, and the rest were commercial planes on loan from Pan-American Airways and Trans-World Airlines, or purchased by military aviation from these companies. Not one was good enough for flying precious cargoes across oceans and mountains.

In 3½ years this puny unit transformed itself into the mightiest international air transport system yet developed. Its air bases were well-equipped and completely manned for weather reporting; its routes, a network of intercontinental airways, embraced the world, binding the earth more closely together than had ever been possible before. Its transport aircraft were the best that could be built.

Civil and Military Air Transport Cooperation

The Air Transport Command (which today, along with the Navy Air Transport, comprise Military Air Transport Service) helped change the pattern of world aviation. It established air transportation as a vital arm of war. Its remarkable postwar achievement in the Berlin airlift established it also as an instrument of national policy in peacetime. Considerable credit for helping to get the Air Transport Command off the ground in time of crisis goes to the airlines. Their equipment, training, crews, skilled personnel, and priceless organizational experience provided a necessary foundation upon which to build a military air transport organization.



After the war the Air Transport Command repaid the airlines with interest. It gave them a complete network of intercontinental airways, ready for long-range air transport operation. It gave them technological knowledge that ordinarily would have taken a decade or two to acquire. The pressure of war allows no time for experimentation. You take a chance and keep your fingers crossed. Hundreds of C-46 and C-47 aircraft, both twin-engine planes, were used to lift tons of cargo over the treacherous Himalayas. Each operation of each of these planes brought new information. Each flight over the Hump and across an ocean was, in a sense, an experiment. And, each flight contributed to a mass of data on airlift performance and efficiency which in peacetime would have taken 20, rather than 3½, years to accumulate.

Civil Reserve Air Fleet

As the postwar airlines profited from the wartime activities of the military air transport, so today's military air services profit from airline operations. One of the urgent lessons coming out of the war was the importance of commercial air transportation as an essential arm of our national defense. As a potential military auxiliary, today's civil airlines are closely tied to military aviation through a task force known as CRAF (Civil Reserve Air Fleet). This fleet is subject to call by the Defense Department on 48 hours notice. CRAF could conceivably spell the difference between victory and defeat should the country be drawn into war.

The CRAF airline fleet is currently made up of approximately 325 four-engine aircraft, consisting of Douglas DC-4's and 6's, Lockheed Constellations, and Boeing B-377's. Some have been partly modified for military purposes. All are in commercial operation, but earmarked for military use when needed. Their value has been placed at approximately $400,000,000. That is what it would cost the government to buy such a fleet. Added to the airlines' annual cost of training its crews and of maintainance, the value of CRAF approaches three-quarters of a billion dollars.

The airlines have come a long way in terms of their importance to the national defense, their contribution to the country's economy, and the quality of their service. Yet, their potential usefulness has barely been tapped.

The Airline Slump of 1946 and 1947

Less than ten years ago, the future for the airlines looked grim. The fiscal year ending June 30, 1947, brought one of the most serious crises of their history. The 1947 operating loss of the air transport industry approximated $22,000,000. As contributors to the country's economic welfare and national security, the airlines were in poor shape indeed. Their financial difficulties were caused by a number of reasons. One of these was the overestimation of the volume of passenger traffic at the end of the war. Both the airlines and the government concluded that high wartime patronage would be a permanent feature of the business. To make up for their great shortage of planes and personnel during the war, the airlines went on a buying and hiring spree, unwisely overextending their routes and expanding their services and organizations. Other causes were unexpected cost rises coupled with reductions in passenger fares, a decline in mail volume, a succession of dramatic accidents, public dissatisfaction over schedule unreliability, and strikes! The resulting financial burdens were great enough to ruin a mature industry.

Because of the growing importance of the air transportation industry to national economy and defense, the authors of the Civil Aeronautics Act of 1938 agreed that commercial air transportation must be kept strong. Consequently, they empowered the Civil Aeronautics Board to adjust the mail pay so that the operating losses suffered by air carriers would not be fatal. Had this practice not been in effect the airlines could not have survived through 1946 and 1947.

Public Service Revenue

The governments of all nations are concerned with the development of both their civil and military aviation. In many countries, the government owns and operates the civil airlines, controlling them as a state monopoly. In others, the government is a large stockholder. And in still other countries the government assists in the management of civil airlines. Some countries consider their civil airline operations as part of their military air programs.

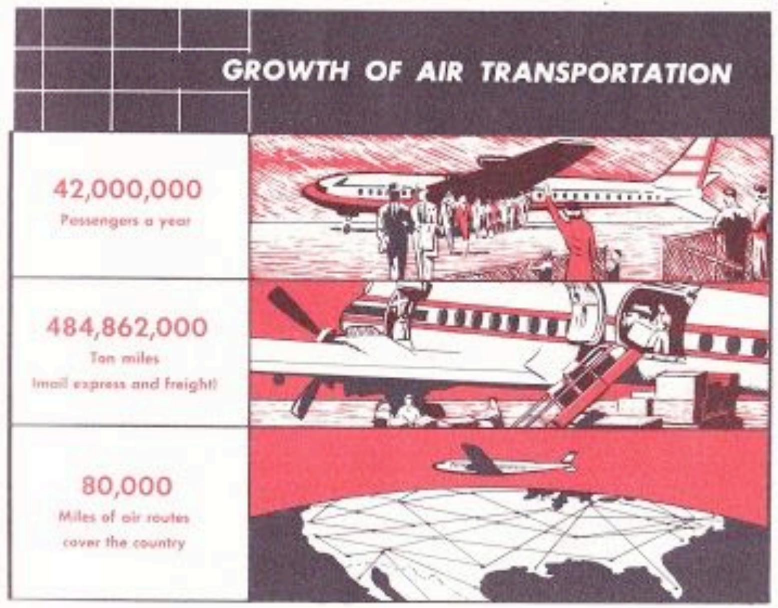
The policy of the U. S. Government has been to regard civil aviation as a business to be operated by business men with a minimum of government supervision and support. In effect, this means that the airlines can continue to operate only if they make a profit. The government wants them to make a profit because only in that way can the lines provide higher quality service at a low cost while serving the nation's foreign and domestic commerce, its postal service and its defense program. It is the federal government's policy to promote and encourage civil aviation to accomplish these things.

To effect this policy, the government will, when necessary, assist the airlines through subsidy so that they can become self-sustaining. In our nation's history there has been subsidy to promote the development of railways, waterways, roads, and many other facilities of benefit to the public. One may regard airline subsidy as public

service revenue authorized by Congress. The development of air transportation so that it can serve better the nation's commerce and its Postal and Defense Departments justifies financial support from public funds.

In 1938, mail payments to the airlines included both subsidy and payment for service. It was rendered to a carrier all in one pay check. This practice was followed until 1953.

In 1953, it was decided to separate mail pay from subsidy. Mail pay became dollars earned by the airlines for carrying the mail. Today, some airlines get two pay checks from the government—one from the Post Office Department as mail pay, the other from the Civil Aeronautics Board as public service revenue, or subsidy. There are three major reasons for continuing subsidy today: (1) to help provide air service to smaller communities which could not support it; (2) to help some of our international carriers compete with the airlines of foreign countries, most of which are heavily subsidized; (3) to help further and develop the young helicopter services. The matter of subsidy also enters when the public interest requires the replacement of aging

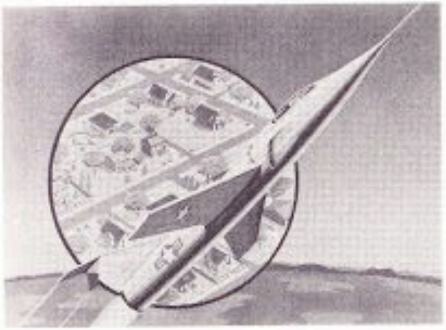


equipment with new types, when more costly operating procedures are necessary in the interest of safety or when economy dictates the consolidation of airlines.

Does this mean that the government is doing the airlines a favor by providing them with enough money to keep operating? Not at all. It means that the government is purchasing a specific service that the country needs.

Airline subsidy is steadily diminishing. In 1951 public service revenue represented more than 7½ percent ($75,800,000) of total airline revenues; in 1955, subsidy payments to all airlines were reduced to about four percent ($66,150,000).

Today, the domestic trunk airlines, which carry the bulk of air commerce, are virtually subsidy-free. This has come about, not by eliminating the service requiring it, but because the growth of passenger traffic has made the trunk lines self-sustaining. Also, subsidy payments received by the local service carriers have dropped from 47 percent of the total revenues in 1951 to 40 percent in 1955 and such payments received by the international airlines have dropped from 13 percent of the total revenues in 1951 to 8 percent in 1955.



CHAPTER FIVE

V. AIRPORTS AND THE COMMUNITY

The condition of the nation's airports is of great concern both to the federal government and to the local communities which have the primary responsibility for airport development. Adequate airports are essential to the strength of the nation's communication and transportation systems. Adequate communication and transportation systems are vital to the nation's economy and defense. The local communities in particular benefit by the social and economic growth good airports stimulate. So, both the federal government and the local community should cooperate to maintain a sound national program of airport development.

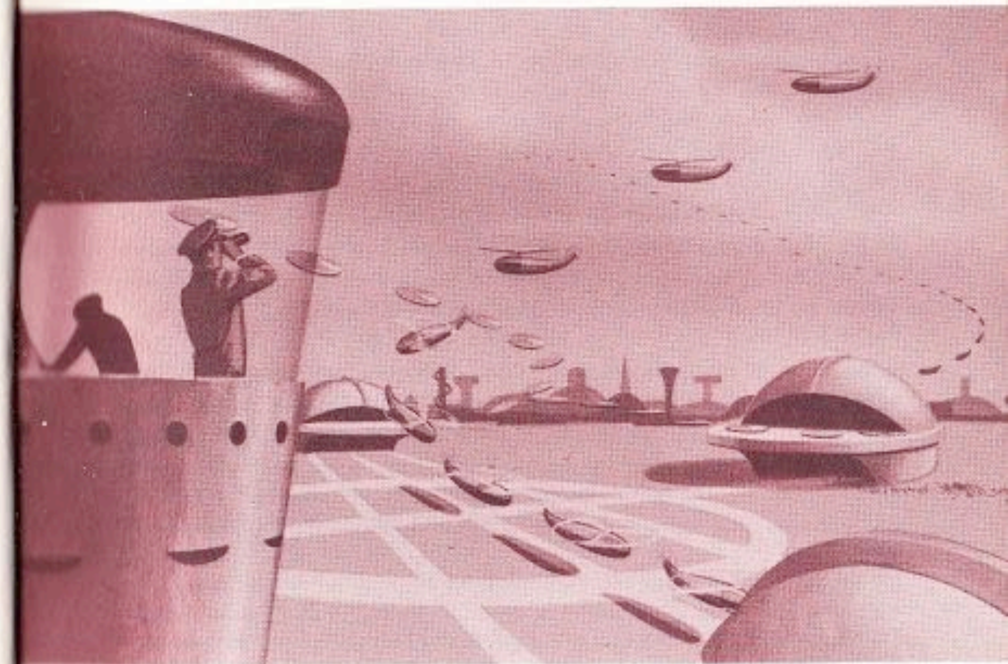
Today's modern airport bears little resemblance to the airport of the 1930's. As aircraft design and characteristics change, airports must change to accommodate them. Airport development has had to struggle in order to keep pace with aircraft development. For, an airport's needs cannot always be determined until the aircraft that use it are put into operation.

Throughout the United States there are many airports that in themselves have kept pace with aviation's development. It is with respect to the development of a national airport system that the airport development program invites criticism.

The Need for a National Airport Program

Since 1946, there has been a great expansion in air passenger travel and in domestic and international air commerce. To accommodate this expansion there is an increasing need for many new modern airports. Some existing airports lack the traffic control facilities needed to handle air traffic at peak periods. The air space around others is crowded. The runways of many are too short for today's big transports and much too inadequate in all respects for tomorrow's commercial jets. At many airports fuel storage and other airport facilities are likewise unable to serve effectively our rapidly expanding air traffic.

To solve the airport-system development problem requires that present efforts be increased. If this is not done the problem will become increasingly critical. According to a prediction by the Civil



Aeronautics Administration based on a survey of 1955 air traffic trends, the volume of airline passenger traffic will reach 70 million by 1965, an increase of about 30 million over 1955. This survey also indicates that by 1965, business, agricultural, and other general flying activities will be operating at an annual rate of 14 million flying hours, five times the 1954 rate of our domestic scheduled airplanes. A similar optimistic future was predicted for air freight.

Airports and Jets

Jet powered air transports are scheduled to go into commercial airline service by 1958. This fact poses special airport problems. Since the wings of jet air transports are not expected to be much wider than present aircraft wings, the present CAA standard of 200 foot-wide runways for the two largest categories of airports will be satisfactory for jet operations. However, airport runways need to be longer and stronger to handle the faster and heavier jet aircraft.

Among the major CAA standards used in runway construction and extension are field elevation and temperature. Present elevation standards for lengthening runways for commercial piston-type aircraft call for increasing the runway length seven percent for each 1000 feet of elevation.* These standards have not yet been established precisely for jet runways, but they are not expected to be changed too much. For practical reasons, the runways of many of the nation's existing airports cannot be lengthened. This means that communities served by jet transport aircraft must build new airports.

Because of its greater fuel-carrying weight, the departing intercontinental jet flight will need a runway of 10,000 feet, twice that being planned for domestic airline jet operations. Today, less than 150 of our public airports have runways of 7,000 or more feet. Of these, only a few at present are suitable for intercontinental operation. For example, the longest runway at New York's Idlewild International

*Temperature standards are based on correcting length upward by one-half of one percent for each degree that the mean temperature of the hottest month of the year exceeds 59 degrees.

Airport is 9,422 feet. In the light of altitude and temperature factors, its effective length is only 8,724.

The runway situation for domestic and international commercial air activities is not yet crucial. However, future air traffic expansion and jet aircraft operation will generate critical problems.

Air Traffic Congestion

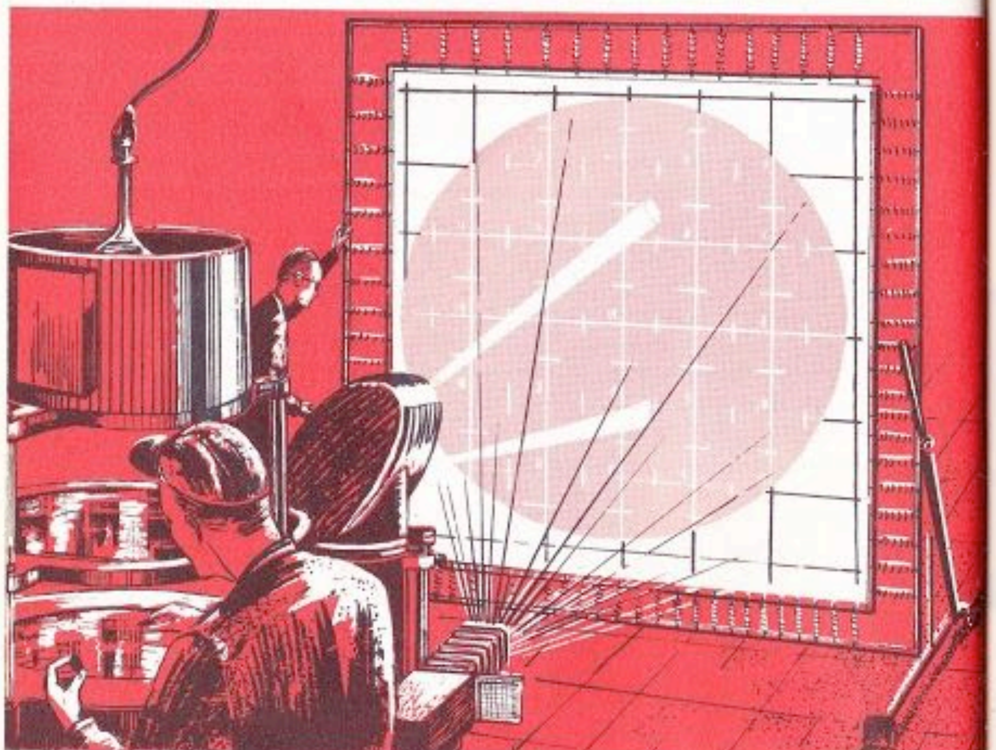
Our airways are not much better equipped than are our airports to handle jet flight operations. One big difference between aircraft powered by jets and those powered by reciprocating engines is speed. Another is the altitude at which each operates most effectively.

In good weather at a major airport with careful air traffic control from the tower, planes can land and take off at a rate better than one a minute. In instrument weather, a major airport does well to handle 30 landings and take-offs in an hour. It is the current practice for aircraft whose landing is delayed by instrument weather conditions, each to hold at a different altitude until cleared to land by Air Traffic Control. High jet fuel consumption and high jet speeds make this practice of stacking questionable.

The air traffic problem for the very near future will be to provide safe separation for modern civil aircraft while they are in the air awaiting landing instructions. Jets cannot be kept waiting. Air Force officials, for example, have estimated that when a B-47 starts coming in for a landing and either misses the approach or for some other reason must return to the traffic pattern, it will have consumed more than 2,500 pounds of jet fuel (about 400 gallons) before it can make a second approach.

Federal Aid

Through the Civil Aeronautics Administration the federal government is responsibile for providing suitable airways facilities to improve the nation's airports and make air travel safer. To relieve today's air traffic congestion and to prepare for the future expansion of air traffic, the Civil Aeronautics Administration has worked out with civil and military agencies a five-year $40 million program for installing new traffic control aids. The new equipment will do two things: It will keep fast-moving planes constantly in sight while they are in the upper air space (24,000 feet); it will help bring them down promptly and precisely when they approach the airport. Other new equipment will include long-range radar that will permit observation



of the airspace up to distances of 600 miles from its station. The installation of this electronic equipment got underway July 1, 1956. It should be ready for service before the arrival of the civil jet transports.

Installing and operating traffic control aids are just part of the government's program to assist in the improvement of civil air operations. Much bigger in scope is the federal program for airport construction and modernization. Approved by Congress under the Federal Airport

Act of May 13, 1946, the program authorized the use of $500 million of Federal money for airport development over a period of seven years. (See *Airports, Airways, and Electronics*, page 3.) The Act provided that these funds should be apportioned to the various states on a population-area basis to be matched 50-50 by local sponsoring agencies. Bear in mind that this money was to be made available only if the local community qualified for it, and only if it was able to put up a matching amount as its share in the enterprise.

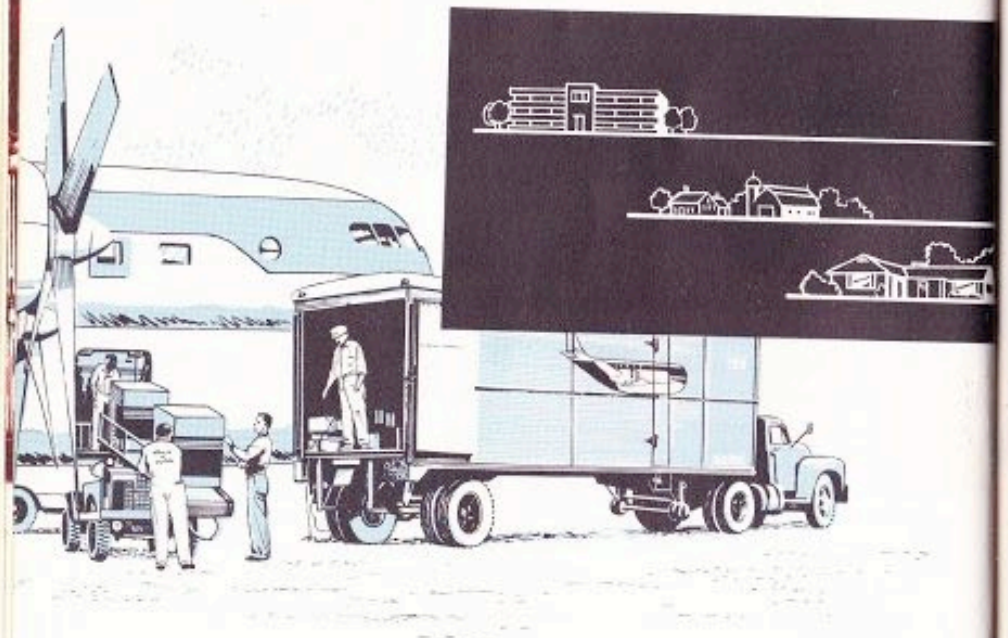
From July 1, 1946 through Demember 1953, less than $196 million was appropriated of the $500 million originally authorized. The program was held up in 1954 so that federal officials could take a new look at the program of federal airport aid. It is possible that the full amount of the original authorization was not appropriated because of irregular community response to the programs during the seven-year period airport aid was available. However, enough communities wanted it to justify its continuation. For fiscal year 1955, Congress appropriated an additional $20,750,000; and on August 3, 1955 an amendment to the Act of 1946 was approved that made $252 million available in airport aid to cover a period of four years beginning July 1, 1955. The money was to be apportioned at an annual rate of $63 million.

In the first year of the program the number of airports went up from 4,490 to 5,759; the increase was chiefly the result of the great postwar interest in aviation. By 1949 a total of 6,484 airports had been built. Thereafter, airport construction proceeded more slowly, and during the next three years 442 unmodernized airports stopped operations. Early in 1953, however, airport construction was revived, and by March 1954, the nation counted 718 additional airports, for a total of 6,760. However, of the 6,760 airports active on March 1, 1954, only 1,291 were paved.

Community Obstacles to the National Airport Program

Failure of community leaders to provide matching funds explains the present, apparent inadequacies of the nation's airport system. This failure can be explained in terms of the pressure of other community needs. Airport construction and modernization is made easier by federal aid, but the community must still raise the funds for its share of the airport building costs.

Many communities have no airport because community leaders do not agree that airport construction should take precedent, for example, over the building of a modern hospital. Other communities are influenced by fear. Air traffic accidents have happened. The fear that such will reoccur remains long after the condition that caused them has been removed. The noise that offends those who live adjacent to an airport is almost as intense as that which shatters the ear drums of those who live near a railway.



These obstacles to the development of an airport system are real. There is merit in the objection to airport noise. However, if a com-

munity temper antagonistic toward aviation were to spread throughout the nation, it could threaten our national defense program and put an end to the growth of air commerce.

Community Advantages of the National Airport Program

A modern airport can literally change the face of a community. It can put a small community on the map. The lack of an airport could conceivably remove a large community from the map. For transportation and commerce is the economic life blood of a community, and air transportation is emerging as a dominant factor in modern commerce.

Modern industrial plants include airports in their scheme of operation. The trend of great manufacturing companies toward dispersion has brought about an industrial migration from metropolitan centers to less congested areas. New plants are opening in communities near sources of raw materials, of water, fuel, and electric power, and of labor. This trend has increased the economic importance of the airport. Executive travel, air express and freight service, air mail—all these make an airport necessary. The industrial use of the airport has become routine. The community without one should not expect to attract expanding industry.

The airport construction requirements of themselves add to the prosperity of a community. Workmen, machinery, and materials, must be supplied by the community. These demands upon the community for services and commodities open up hundreds of new jobs that did not exist until the work of building the airport got underway.

After an airport begins operating, its contributions to the welfare of its community become even more pronounced. Well-managed community airports show an income from rents, concessions, and utility fees that not only covers all operating costs, but also provides a generous profit on the original construction costs. The income from some community airports has been so great that the costs of their construction has already been recovered.

Once an airport is in operation, new roads must be built so that taxis, busses, and trucks can reach it with patrons and cargo. Those who work at an airport choose to live in its vicinity; hence an airport becomes a boon to the real estate market. It has been estimated that 50,000 people settled around one of the major, east coast air terminals.

As a matter of fact, a sound national airport construction program offers a solution to a major community airport problem—the over concentration of air traffic at a single airport. The construction of additional airports to relieve heavy air space congestion at certain of the nation's air terminals will be a move in the interest of safety of air operations.

The benefits reaching the community that builds an airport are real. One only needs to multiply these by the number of American communities not served by a modern airport (an estimated 30,000 to 50,000) to discover the worth of the nation's airport program to her economy and air power.

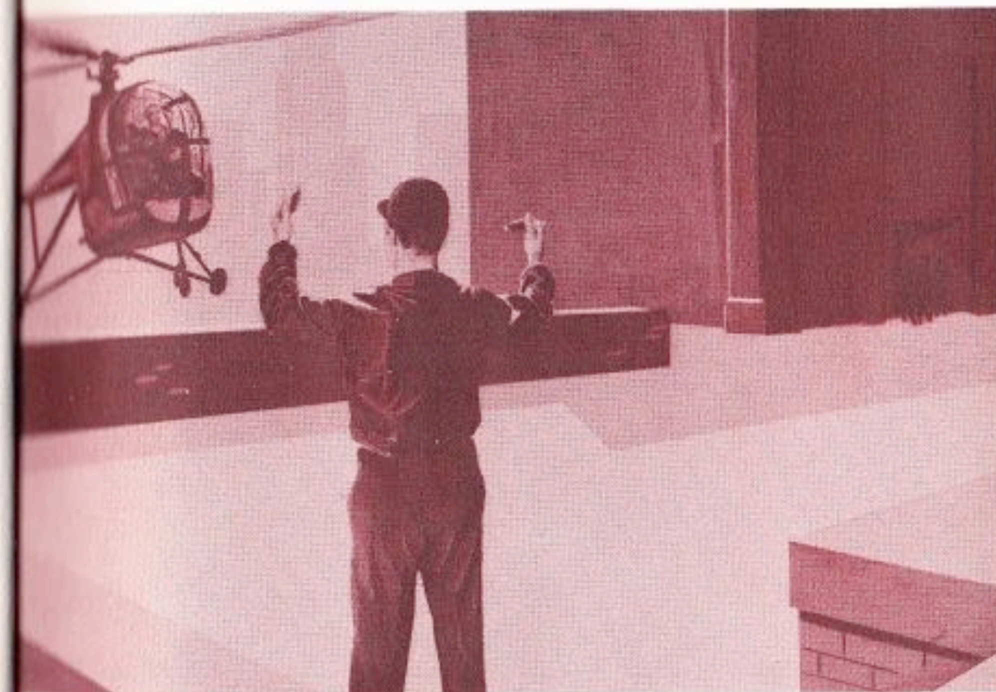
The Metropolitan Airport Problem

Large metropolitan centers have special airport problems. The airspace available in some areas has reached the point of saturation. The belief is growing among airport engineers that it would be practical to build special airports for special services in these areas.

It is becoming both unsafe and impractical to handle all types of transport planes at the same airport. Some big cities already operate several airports, each organized to handle one class of traffic. Military and commercial aircraft seldom operate from the same airport. Flying schools and private flyers no longer operate from major commercial airports.

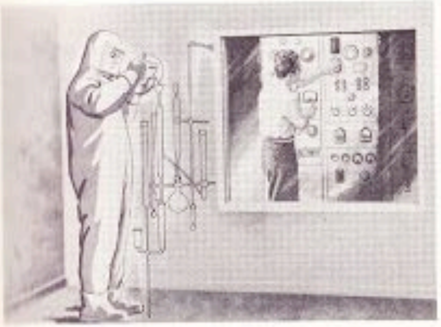
Specialized airports may become just as common as specialized

aircraft, each type designed for a particular job. Should this situation develop certain existing airports may rearrange their facilities. This could mean that a downtown airport would handle only short-haul light plane traffic, since such traffic can be accommodated by parallel

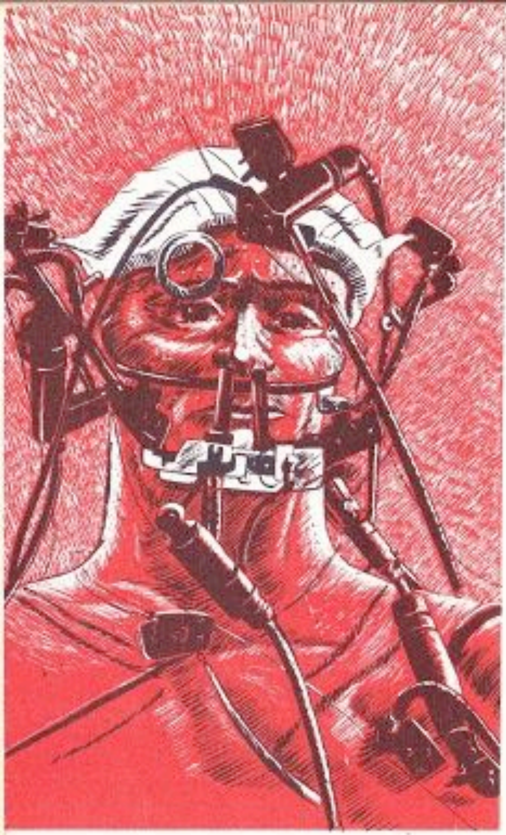


runways pointing in a direction to divert traffic away from the city.

A large metropolitan center, in order to solve its airport problems, might include its downtown airport in an area pattern. This airport pattern would encompass an airport for overseas operation, one for trunk line operation, another as an air freight transportation terminal, and one to handle local and miscellaneous air traffic. A system such as this will require an effective central, air-traffic control. Electronic systems are now in use which will enable the installation of such control. This system would also require an aerial counterpart of taxi and bus service. Helicopters have been developed to the point where they can transport passengers, mail and cargo. The facilities for operating a complex of metropolitan airports is at hand.



CHAPTER SIX



HEAT ON FLESH: Face bristles with devices for recording changing skin temperatures and blood flow.

VI. RESEARCH AND DEVELOPMENT

The Importance of Aeronautical Research

Research has revolutionized aviation. It has provided military aviation with jet and rocket engines, and with supersonic aircraft and guided missiles. It has provided civil aviation with a dependable, fast, and economical means of air transportation. It is helping to solve for both military and civil aviation, the problems of air traffic control and electronic navigation. It appears that our nation's position as a world leader rests upon the success of research and development in aviation.

World War II demonstrated that control of the airspace is a factor essential to the winning of a war. It follows that the nation with the best Air Force is in the best position to win a war, or to deter an aggressor. For a time after World War II, it appeared that the nation's

leaders had forgotten the costly lessons that the war had taught. Hasty demobilization seriously disrupted the little research in jet and atomic powered aircraft then underway. In view of the keen technological competition in aviation emerging among leading nations of the world, this move proved an unfortunate handicap.

The Korean conflict, however, brought another change of leadership attitude. The early 1950's saw a rebirth of aeronautical research. By 1955, a 600-mile per hour intercontinental bomber powered by eight jet engines was in operation. To create an air power capable of preventing war, or if this is not possible, able to seize control of air space from an aggressor, requires that the nation's air policy maintains a continuous and expanding program of air research.

Organizations Conducting Aeronautical Research

Of the total national aeronautical research effort, industry conducts about 50%; non-profit groups (including colleges and universities) conduct from 15 to 20%; and the rest, 30 to 35%, is carried out by the military air services and the National Advisory Committee for Aeronautics (NACA), and the National Bureau of Standards.

At present there are some 1800 Air Force research projects underway. They are administered, under federal government contract, by 1500 industrial firms and 150 non-profit educational and private research institutions. The U. S. Air Force Air Research and Development Command (ARDC) monitors these projects through its 26 technical liaison offices. In addition to this research function, the Air Research and Development Command operates 10 research centers of its own.

The testing of new equipment produced by the research groups is the function of the USAF Air Proving Ground Command.

The National Advisory Committee for Aeronautics' primary job, as established by Congressional action in 1915, is to formulate research programs and coordinate the efforts of the nation's aviation interests in solving leading aeronautical problems. As a coordinator of research projects, it shares responsibility with the Air Force in those areas where the Air Force has an interest. NACA, in addition, maintains five large research laboratories that conduct basic and applied research in one or more of four major problem areas: aerodynamics, power plants, aircraft construction, and operations. Our rapid development in jet powered aircraft would not have been accomplished without the research and wind tunnel experimentation of the NACA.

Our Supersonic Air Force

We are building a completely supersonic (750 mph at sea level) aircraft inventory. The F-100 C SUPERSABRE is replacing both the F-86A SABRE day-fighter and other similar fighter aircraft. Production has been speeded up on the F-101 VOODOO long range strategic fighter and the F-104 day fighter, both supersonic. The F-102, America's first supersonic, delta-wing fighter intercepter, equipped for all-weather flying, is in production. Deliveries of this aircraft are beginning to be made to the Air Defense Command. The F-105A, a supersonic fighter bomber capable of delivering at extremely high speeds boih nuclear bombs and rockets,is in the advanced stage of development.

The B-52 intercontinental STRATOFORTRESS is replacing the B-36. Powered by eight jet engines, it is virtually 180 tons of awe-inspiring power. Incidentally, its design appeared so good that in spite of the Standard Operating Procedure (SOP) requiring that before their acceptance new planes should be flight tested, the Air Force directed that the B-52 be put into production, even before a prototype was built.

Eight years of research effort resulted in the development of the B-52. Research is not, however, content with its achievements. It looks into the future. Consequently a supersonic, long range bomber, the B-58, faster than the B-52, is already undergoing development.

The six-jet B-47 medium bomber has been adopted as the "work horse" of the Strategic Air Command. The B-26 and the more modern

B-45 jet light bombers are being replaced in Tactical Air Command and in overseas operations by the twin jet B-57 Canberra and the B-66 light bombers.

Vast progress has been made in aircraft development to meet air logistics requirements. The C-103A HERCULES four-engine turbo-prop transport has been placed in quantity production. The C-132, a giant turbo-prop transport with greater range and payload than any other cargo aircraft, has reached the final stages of development. The C-133A, another four-engine turbo-prop cargo ship, is undergoing tests. Tanker versions of Boeing's 707 four-jet passenger transport have been ordered.

Experimental aircraft are flying nearly three times the speed of sound and are approaching the threshold of space, almost 20 miles above the earth. The Air Force is developing jet-powered vertical takeoff aircraft, and exploring the possibilities of disc-shaped aircraft. Experiments with nuclear-powered aircraft disclose that built-in controls can make the nuclear power plant no more dangerous (from radioactivity) than other types of power plants.

Electronic Research and Development

In the interest of national security, an Arctic radar warning system is undergoing construction. Man-made radar islands are now operating off the eastern Atlantic coast. Perhaps the most significant air defense development in recent years that research has produced is the Semi-Automatic Ground Environment System (SAGE). This device utilizes high speed electronic computers to receive and analyze information. Almost instantaneously it can portray to an Air Force section commander an air defense battle in picture form. This warning system is being tested as a possible means of easing growing air traffic congestion over our large metropolitan areas.

In the field of guided missiles, the Air Force has either in operation, or under development, weapons in each of the four missile families: surface-to-surface, surface-to-air, air-to-air, and air-to-ground. Strategic, long-range, surface-to-surface guided missiles include the Northrop SNARK and the North American NAVAHO.

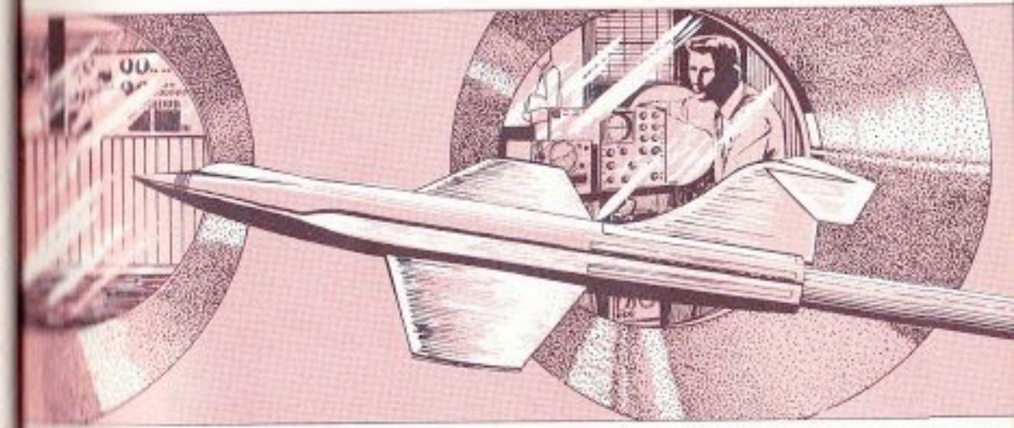
The SNARK is a pilotless bomber, powered by conventional jet engines. Automatic computers take the place of a crew. It has a cruising range of approximately 2000 miles. It is expected that further development will increase its range to 5000 miles. Its speed is just over 600 mph and it is relatively simple and inexpensive. It is adaptable enough for many different uses over a variety of ranges. The NAVAHO is a similar missile, capable of faster speeds.

The BOMARC, a long range surface-to-air pilotless interceptor for use in air defense, is under development. The FALCON, an air-to-air guided air defense rocket, is in the final stages of development. A strategic air-to-ground missile, the RASCAL, is also in the final stages of development. It can be "dived in" from as high as 75,000 feet at tremendous speed. The MATADOR, a tactical surface-to-surface missile, is a pilotless jet aircraft capable of carrying an atomic warhead 500 miles. It is shot into the air by a small rocket, which falls away. A jet engine then takes over and propels the missile through the air. Its rudder and elevators are controlled by radio operators on the ground or in flight. Several MATADOR squadrons are now operating in the European theater.

The development of the Intercontinental Ballistic Missile (ICBM), is underway. It has been given a very high Air Force priority. All of the above-mentioned missiles are subject to interception because they operate in the earth's atmosphere. The ICBM is a space missile and, unlike those discussed above which operate within the earth's atmosphere, it cannot be intercepted. It might well decide the outcome of any future war. More brainpower and funds are being poured into the development of an Intercontinental Ballistic Missile, called the ATLAS Project, than went into the Manhattan Project that produced the atom

bomb. It is still in a very early developmental stage. It will take several years to bring it to an operational status.

ATLAS, the Intercontinental Ballistic Missile, will look like a giant rocket. It will have a height of from 80 to 130 feet and a width of about 10 feet. It will have, approximately, a million working parts. It will consist of five major sections. Its nose will consist of a thermonuclear warhead. The nose will be followed by a guidance system, fuel tanks, fuel pipes, fuel pumps, and rocket engines. It will be aimed like an artillery shell and propelled vertically into the air by its engines. As it nears a pre-determined altitude (600-800 miles up), it will assume a horizontal trajectory and break in two behind the warhead, the



body falling into space, leaving the warhead speeding toward its target at a speed of 10,000 to 16,000 mph. A single missile could leave a major city with 500,000 casualties. Two could totally destroy such a city. A hundred could cause 50,000,000 casualties, and could destroy one third of the industrial facilities of any nation. All this could happen in a period of 30 minutes.

The problems of developing the ICBM are the most baffling ever encountered by science. One major problem relates to the vaporizing effects that the missile's blistering speed will have on the metals that form its structure. Another major problem deals with the electronic devices needed to keep it on its 5000-mile course. The solution to such problems and to the many others that plague our scientists and engineers motivates persistent probing into the nature of high speed aircraft and missile flight.

The Role of the Supersonic Pilot

Most of a jet pilot's flying time is taken up with watching the gadgets on his instrument panel that are the "brains" of the hundreds of pounds of electronic equipment which really do the work once the plane is aloft. These gadgets steer his airplane, inform him when he is on course, keep him on course until he nears his destination.

If he is a military pilot they also inform him when to release his rockets or bombs. Then, after he places the plane back on course for the journey home, electronic devices guide it home and help the human pilot to land it at his base. But, nothing has yet been developed that takes the place of human judgment. The human, in this respect, still retains superiority over the machine, and is expected to retain that edge for some time to come.

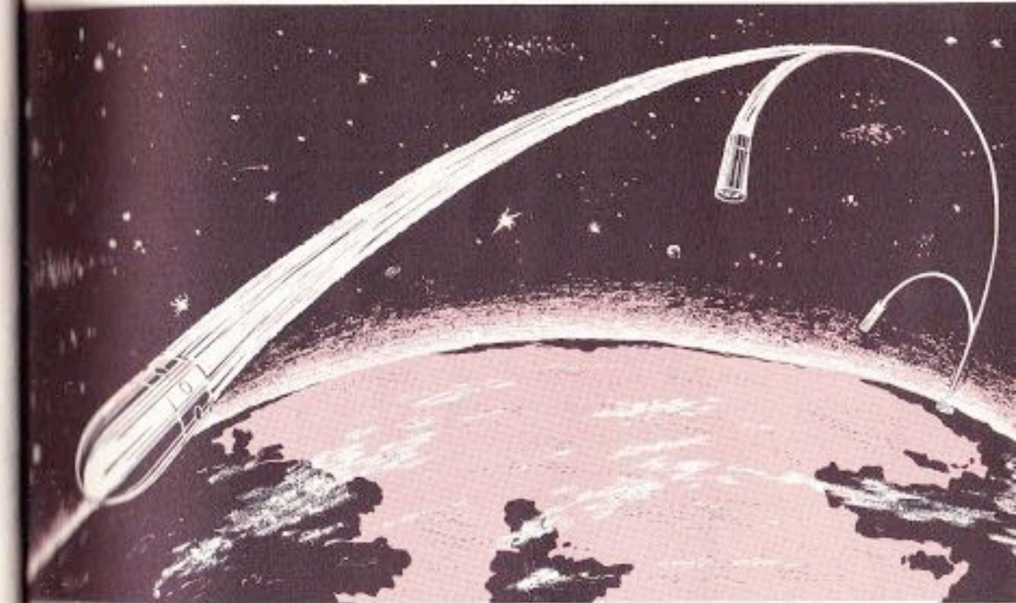
The Problems of Supersonic Flight

October 14, 1947 may well become as important a date in the history of aviation as the date the Wrights flew the first powered airplane. October 14, 1947 was the day when man flew faster than the speed of sound. It happened at 21,000 feet over the Mojave Desert when the rocket-powered Bell X-1, an experimental model, was released from the belly of a B-29 with Captain Charles Yeager at its controls.

Aviation's problems didn't cease the day Captain Yeager crashed the sound barrier in his tiny rocket research plane. In fact, this achievement introduced a whole new succession of problems for research. It now appeared important to develop a practical plane with a useful range and load-carrying capability which can duplicate the feat of the Bell X-1. To develop such a plane is no easy task. It was discovered that as an aircraft entered the transonic speed range (750 mph at sea level) it experienced a sharp rise in drag, caused mainly by skin friction. It was Richard T. Whitcomb, NACA scientist who, by using a unique transonic wind tunnel, discovered the solution to this drag problem and advanced the now famous area-rule concept of design.

The design employed by supersonic aircraft now includes a thin, sweptback wing and a streamlined fuselage, pinched at the point where

wings and fuselage meet. Such a design gives the aircraft a "coke bottle" shape which offers minimum resistance to pressure drag. One of the most important technical advances resulting from the area-rule design was the discovery that wings and fuselage must be designed together for best aircraft performance. The new concept boosted military aircraft performance by 25%.



Now we are on the threshold of the "thermal" barrier, encountered at aircraft speeds of 2000 mph. This is a point in the high speed range where both pilot and plane can burn up. The reason is this: the faster an aircraft travels in the earth's atmosphere the greater the heat generated by the friction of the air over its surface. The greater the heat, the greater the loss of strength in structural materials. Aluminum, for example, cannot be used in high speed aircraft because at sea level speeds just under 1000 mph it will soften and warp. The plastics used for cockpit hoods and radomes lose their shape at speeds of 800 mph sea level. At 1600 mph, today's engine fuels boil; the combustion products in the newer and more powerful jet engines become highly destructive; and metals lining the walls of compression chambers are put to severe tests of endurance.

At the same time engines must be developed with sufficient thrust to counteract the effects of the high altitude's thin air on the weight and drag of the airplane. Thrust and speed can be increased by increasing the operating temperature of the power plant. But what materials can be used to prevent the engine from burning itself up when the engine temperature reaches 2000°F? It's a tough problem in metallurgy. In the meantime, as combat planes reach higher and higher speeds, the cooling ducts installed under, around, and behind the pilot must be made more and more powerful to prevent him from being roasted.

The Thermal Problem and Engine Operation

Beating the heat barrier as it affects fuels, as well as engines, aircraft and missile structures is one of the important problems of research. Researchers are working on two different types of fuels. One called "exotic" is a non-hydrocarbon fuel in which chemicals such as boron, hydrogen, and lithium are used. Another called "slurry" is a suspension of powdered metal in a liquid solution. Coolants like ammonia are used to help obtain greater thrust from jet fuels without burning combustion chambers.

To meet the problem of high engine speed lubrication and wear, synthetic lubricants have been found to be superior to petroleum oils because of their higher range of operating temperatures (up to 1000°F). Transpiration * cooling is being used experimentally to keep down the temperatures of turbine walls exposed to hot gas streams. Also, porous metal used for aircraft skin can be caused to sweat by pumping coolants through its pores. Turbine blades made of nickel-base alloys have heat resisting quality superior to those made of other high temperature alloys. It has also been found that by increasing the quantities of titanium, molybdenum, and chromium and decreasing that of aluminum, these

*Transpiration means to emit or leak a fluid through a porous substance.

nickel-based alloys can be strengthened to withstand temperatures of 2000°F. Steady progress also is being made to devise various ceramic coatings for protecting metals from heat corrosion. However, some researchers believe that the solution of the thermal problem lies in a combination of ceramics and metals (cermets).

Other High-Speed Problems

While solutions to the problems of supersonic heat are being sought, greater aircraft power is being developed at an increasing pace, giving rise to other kinds of pressing problems. These concern the effects of high speed on aircraft structural components and introduce new technical problem terms like fatigue cracks, aeroelastic vibration, flutter, buffeting, and wing dropping. When an aircraft flies at twice the speed of sound, wind blasts set up vibrations in structures so intense that the plane may fly wildly out of control or the wings may rip off suddenly. At these speeds fatigue cracks develop and continued pressure will cause pressurized fuselages to blow up with the force of a catastrophic explosion.

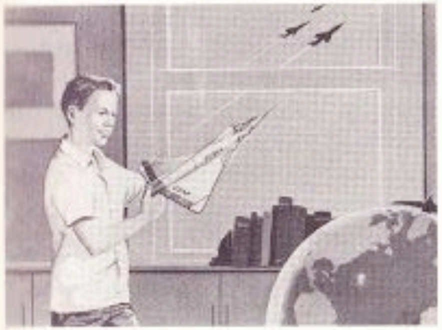
Aeroelastic vibrations can be reduced by using stubby wings of reduced size. Thinner wings are used to help ward off shock waves. Such changes in design make some of today's research planes look like projectiles or missiles. The new shapes, however, still do not solve all the problems.

The lack of stability in pilotless rocket aircraft, long a problem, is being investigated with renewed vigor as a result of certain encouraging tests. It has been found that considerable aircraft instability can be eliminated by locating the center of gravity of the rocket engine propellant at the center of gravity of the aircraft and conveying the jet exhaust to the rear of the plane through exhaust pipes.

To find the answers to such aerodynamic problems as vibration and instability, elaborate testing facilities must be employed to create the actual conditions aircraft and missiles encounter at supersonic speeds. By the use of such facilities scientists can obtain the data necessary from which to discover solutions to the perplexing problems created by high speeds.

Before research can obtain needed data it must build wind tunnels capable of generating air speeds from 2000 to 4000 mph. It must construct altitude chambers which will duplicate air pressures found between 8 and 15 miles above the earth's surface and temperatures from 200°F above zero to 100°F below. Research must design instruments to study the effects of heat on metal in 3000°F temperatures—for this is the temperature that would be generated by an actual plane or missile moving at 4500 mph through the atmosphere at sea level.

Such test facilities are just as necessary in today's battle for air supremacy as actual weapons because both man and machine are subject to the extreme conditions these testing devices are able to create, and ways must be found to permit both man and machine to survive them.



CHAPTER SEVEN

VII EDUCATION AND AIR POWER

The Magnitude of the Air Education Problem

The outcome of the struggle for air supremacy depends upon the quality of the machines of the air. But to an even greater degree it depends upon the quality of the education and training received by both those who develop and operate the machine, and those for whom the machines are operated. We comment upon the fact that it takes eight years to bring an aircraft from the drawing board stage to the testing stage of development. We appear to forget that it takes eighteen years for a young man or young woman to reach maturity. And, that an air age demands, during this period of growth, an education which differs greatly from that of the horse and buggy era.

The problems of air education overshadow all air power problems. For, the solution of these other air power problems depends upon whether or not disciplined intelligence can be brought to bear upon them. All three major areas of education—the professional, the technical, and the general—help solve air power problems. Education at the professional level produces aeronautical scientists and engineers. That the need for these currently exists is pointed up by the fact that they are in such short supply that one industry competes with another to secure their services.

Experimentation by scientifically inclined young men brought the airplane into being. Men trained in science and research in later years refined the achievements of these earlier inventors. Until recently the course of such developments in aviation was left to chance. Today, however, we are confronted by a situation that requires the concerted planning, the creative imagination, and the coordinated energies of many trained people.

Education at the technical level provides the man power to operate our air power. That the need exists for technically trained personnel is demonstrated by the fact that aviation has become the nation's largest industry. It employs almost one million men and women. Moreover, the needs of military air power require the service of another million. These millions need technical training which in most instances consumes a considerabe period of time. The aircraft today is a highly complex machine. Only skilled operators can master its complexities.

Education at the general-education level (aviation education) is concerned with the aviation attitudes and understandings that the average air age citizen should develop. That the need exists in the aviation education area is typified by the negative attitudes which many hold toward air bases or airports located near their communities. It is reflected in the periodic turnover of Air Force personnel. It can be emphasized by the lack of general understanding of the impacts of the airplane upon our way of life.

The Role of Formal Education in Aviation

Education has been defined as a process that brings about changes in one's behavior. The men who invented the airplane were educated (in some instances self-educated); through their changed behavior a way was found for man to fly. Aviation has gained its present prominence because of the change in behavior of those who once used surface transportation but now use air transportation.

Education is learning; and learning is gained through experience and at the expense of time. It took time for us to learn that the nation's air power depends upon a strong aircraft industry, a strong civil air transport system, an adequate system of airport and air bases, and an effective research and development program.

As a nation we have become convinced that our national security depends upon an air strength second to that of no other nation. It follows that we must take a course of action that will achieve this goal. This implies education and training of the millions whose technical skills, understandings, and emotions are involved in doing the work such a course of action requires. Formal education must be recruited to assist with the task.

You have learned that the aircraft manufacturing industry of this country has in the past suffered from instability. You realize the effect of this instability upon the careers of those individuals employed by the aircraft industry. You have learned the relationship of a strong aircraft industry to our national security.

Two parts are played by education in the aircraft industry drama. One of these is to administer the kind of general education needed so that the general public and its representatives in Congress will remain convinced of the need for a stable aircraft industry. The other is to administer the kind of special education that will provide trained manpower.

You have learned that the air transportation industry is considered so important to our national defense and economy, that the federal government both exercises federal control over it and in some instances subsidizes its operations. You have also learned that the airlines cooperate closely with military air transport services, that each shares information with the other to their mutual advantage, and that the airlines hold an air fleet of 325 aircraft in readiness for use by military aviation should an emergency arise.

Again education performs two tasks in the interests of the airlines. It helps inform youth and the adult public of the importance of civil airline operation to the goals of air power. It helps prepare those who seek airline careers.

Many of the operational problems of the U. S. Air Force are similar to those of the airlines. Certainly, formal education needs to help the general public understand the U. S. Air Force, its missions, and its need to patrol the air space above our nation. Formal education also helps youth understand that military aviation not only provides a training ground for those seeking careers in civil aviation, but also provides aviation career opportunities. Moreover, it trains its youth in those essentials which become the basis for more advanced aviation skills.

You have learned of the need for a national airport program. Obviously, the operation of such a program calls for engineers and skilled workmen—individuals trained in our professional and technical schools. Of greater importance to the introduction of such a program in many communities is an education which will bring their citizens to understand both the importance of an adequate airport to the nation's welfare and its value to a community's prosperity.

You have learned of the importance of air research and development, of the progress being made in this field, and of the great research projects underway. These efforts are carried on by educated men. Often the project that employs them is administered by a university—for the role of education in research is a major role.

Schools and colleges generally recognize a responsibility toward the *special* education requirements of aviation. Less often do they recognize a responsibility toward the *general* education requirements of aviation. Consequently, the aviation education movement has not spread among schools and colleges as rapidly as appears desirable. Aviation is a new science. It took many years for people to recognize the practical value of the airplane. It is not surprising that the need to teach its sociological implications has not yet been fully recognized. However, the recognition of the need for a program of expanded aviation education cannot be delayed. Until free men come to understand the nature of the air age and change their behavior accordingly, the continuation of our way of life is threatened.

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